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A recent General Services Administration survey (1985) reported that the number of small computers bought by the Department of Defense increased 11-fold in 1984 over 1983. Of those small computers, the majority were IBM PCs and Zeniths. User complaints about the adequacy of system documentation and error messages of these disk-operating systems (DOS) have been numerous. This study was done to assess the effectiveness of system error messages. A sample of computer system error messages used by three DOS-based microcomputer systems was interpreted on-line by 40 subjects with varying computer expertise, determined by an experience profile administered before the test. On a four-alternative, forced-choice test, subjects correctly interpreted only 57 percent of the error messages. Experienced users correctly interpreted significantly more error messages than inexperienced users even though the contextual cues normally available to them were not present. Both experienced and inexperienced user groups spent equal time on the interpretation tasks, so differences in performance between the two groups


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cannot be explained by time spent on the test. Successful interpretation of error messages by users was more a function of the number of operating systems the users had been exposed to than of any other computer-related experience.

Seventy-three percent of the error messages used were common to the IBM PC system. Not surprisingly, the IBM users demonstrated superiority over non-IBM users in error message interpretation.

Error messages need to be more understandable for both experienced and inexperienced operators in order for them to use their systems efficiently. Most importantly, messages should be specific and prescriptive. Other attributes of effective error messages include prompts that use familiar vocabulary and present feedback in an appropriate format. A future study should involve the redesign of poorly understood messages. Those messages that already yield a high percentage of correct interpretations could serve as controls for measurement of test-retest reliability.

NPRDC-TR 87-1



OCTOBER 1986

# THE RELATIVE EFFECTIVENESS OF COMPUTER SYSTEM ERROR MESSAGES



NAVY PERSONNEL RESEARCH
AND
DEVELOPMENT CENTER
San Diego, California 92152

NPRDC TR 87-1 October 1986

# THE RELATIVE EFFECTIVENESS OF COMPUTER SYSTEM ERROR MESSAGES

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## FOREWORD

This study was conducted within exploratory development task area 525-601-027-03.01 (Human Factors Engineering Support for Non-tactical ADP) under the sponsorship of the Naval Sea Systems Command (NAVSEA-61R2). The objective of the subproject is to provide human factors engineering support to the development of Navy management information systems.

Appreciation is expressed to the military and civilian personnel of the Navy Personnel Research and Development Center who served as users in this study. Especially important were the innovative and timely efforts of Mr. Herb Delute, San Diego State University contractor, in developing and programming the study materials.

B. E. BACON
Captain, U.S. Navy
Commanding Officer

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Technical Director

## SUMMARY

Problem

A recent General Services Administration survey (1985) reported that the number of small computers bought by the Department of Defense increased 11-fold in 1984 over 1983. Of those small computers, the majority were IBM PCs and Zeniths. User complaints about the adequacy of system documentation and error messages of these disk-operating systems (DOS) have been numerous. This study was done to assess the relative effectiveness of system error messages.

Method

A sample of computer system error messages used by the Wang, Zenith, and IBM microcomputers[1] was interpreted on-line by 40 subjects with varying computer expertise, measured by an experience profile administered before the test.

Findings

1. On a four-alternative, forced-choice test (i.e., where chance performance equals 25 percent correct), subjects correctly interpreted only 57 percent of the error messages.

2. Experienced users correctly interpreted significantly more error messages than inexperienced users even though the contextual cues normally available to them were not present.

3. Both experienced and inexperienced user groups spent equal time on the interpretation tasks, so differences in performance between the two groups cannot be explained by time spent on the test.

4. Successful interpretation of error messages by users was more a function of the number of operating systems the users had been exposed to than of any other computer-related experience.

5. Seventy-three percent of the error messages used were common to the IBM PC system. Not surprisingly, the IBM users demonstrated superiority over non-IBM users in error message interpretation.

Conclusions and Recommendations

1. Error messages need to be more understandable for both experienced and inexperienced operators in order for them to use their systems efficiently.

2. Most importantly, messages should be specific and prescriptive. Other attributes of effective error messages include prompts that use familiar vocabulary and present feedback in an appropriate format.

3. A future study should involve the redesign of messages that were poorly understood. Those messages that already yield a high percentage of correct interpretations could serve as controls for measurement of test-retest reliability.

[1]Identification of the equipment is for documentation only and does not imply endorsement.

## CONTENTS

## INTRODUCTION

A recent General Services Administration survey (1985) reported that the number of small computers bought by the Department of Defense increased by 11-fold in 1984 over 1983. Of those small computers, the majority were IBM PCs and Zeniths. User complaints about the adequacy of system documentation and error messages of these disk-operating systems (DOS) have been numerous. The wording of error messages and prompts affects the ease with which novices learn a system and the efficiency with which experienced users traverse a system.

Several dimensions of error messages and other forms of system communications have been studied, such as ways to name objects (Baggett, 1983), ways to abbreviate (Ehrenreich, 1985), word counts and lengths, and readability indices (Kincaid & Delionbach, 1973). Implicit in the learning process of any computer system is the belief that experience with the system is the best teacher and that once the command structure is learned it will not be forgotten. Also it is reasoned that experience with one system will transfer to another and that "computer expertise" is a global skill nurtured by the sampling of as many systems as possible.

Developers of user-computer interfaces have proposed guidelines for the design of error messages which are intended to ensure their effectiveness. Shneiderman (1982) has been a leading proponent and recommends that messages be specific, offer constructive guidance, be user-oriented in style, and have an appropriate physical format. Some system designers argue that the context in which the message appears is the key factor in correct interpretation. For example, the message is understandable because of the particular task the user is doing--a system operation, programming, or software application. Their argument is that the task to be done clarifies what the message means.

Computer experts gain their skills from using different systems to accomplish a variety of tasks. The present study is aimed at determining the effect of generalized computer experience in interpreting context-free system error messages associated with frequently encountered tasks. If message comprehension is a function of the user's learning experiences with computer systems, then computer experts should do significantly better in interpreting system error messages than less experienced users. But, if feedback is presented without the benefit of knowledge about the task to be accomplished, there should be no difference between experienced and inexperienced users in error message interpretation. This study was done first to assess how understandable error messages are and secondly to compare experienced and inexperienced user performance in interpreting them.

## METHOD

### Test Materials

System error messages representative of various tasks from the Wang, Zenith, and IBM microcomputers[1] were sampled and put in the form of a 41-item multiple-choice test. For each item there was one correct and three incorrect responses. Figure 1 reflects the origins of test items; some messages were common to all systems. The messages were drawn from variants of the Microsoft disk operating system (PC-DOS, MS-DOS, Z-DOS).

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[1] Identification of the equipment is for documentation only and does not imply endorsement.

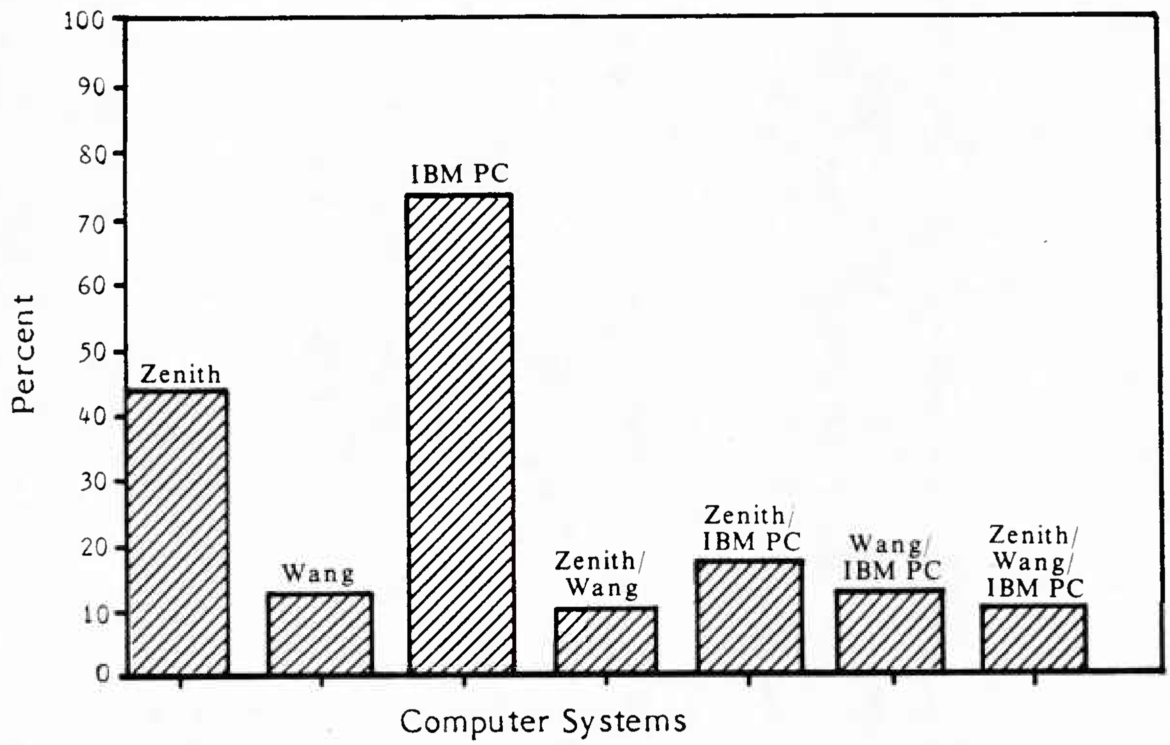


Figure 1. Origins of test items.

Messages were presented to users on the Zenith-120 monitor. The 41 test items appeared in a different random order for each subject. After the examinee received on-line instructions about the nature of the test, items were presented one at a time to the subject, who was kept apprised of how many items remained as an indication of progress. Responses could not be changed once they were entered on the keyboard.

Error message test items represented tasks that all microcomputer users need to perform at one time or another. Of the 41 questions, 17 dealt with disk operations, 11 with file operations, 2 with data transmission, 1 each with the arithmetic, printer, and editor functions, and 8 with error messages that could apply to any of the preceding operations, for example, SYNTAX ERROR. A copy of the test appears in Appendix A.

User Profile

Each subject completed a paper-and-pencil questionnaire about personal background (Appendix B). Information concerned gender, age, highest education level, and specifics related to computer expertise. The computer-related information included items about number of academic courses completed that involved work in introductory data processing (e.g., information science, computerized data analysis). Data were also gathered on the subject's training in computer languages and the frequency of programming in each of these languages during the previous month. If the subject used a computer at home or at work, he or she was asked to indicate the purposes for which it was used and the number of word processing text editors used. Lastly, the types of interactive systems used and the operating systems experienced were recorded. The responses to the questionnaire were scored for each subject; maximum score possible was 52 points.

Allotment of points possible was as follows: Academic preparation (9), computer programming experience (18), purposes and usage (14), number of interactive systems used (6), and operating systems used (5).

## Subject Sample

A total of 40 people participated in the study. The group was made up of 28 males and 12 females, both Navy personnel and civilians. Ages ranged from 14 to over 56 years. Education ranged from junior high school through the doctorate level. Experience was wide-ranging, from subjects who had no specialized computer experience to others with college degrees in computer science. Among the 40 subjects, experience with nine programming languages and thirteen operating systems was reported. Use of computers spanned nine categories (e.g., educational, business applications) and 30 different interactive computer systems.

Profile scores for the 40 subjects ranged from 2 to 36, with a mean of 19.1 and a standard deviation of 9.4. Some subjects had no exposure to computers while others had a great deal of experience with programming languages and with several operating systems.

## Hardware and Software

Test items were presented to the subjects and response data were automatically recorded on a Zenith-120 microcomputer equipped with 704 K bytes memory, a 5.25" disk drive, and a Winchester hard disk. The visual display terminal on which error messages were presented was a green phosphorous monitor; it measured 11 inches diagonally and was built into the computer.

The software that produced the error messages and stored the subjects' responses was developed in Microsoft Z-BASIC. The program's structure is depicted in Figure 2.

## Data Collection and Experimental Design

Of primary interest in this study were the users' scores on the 41 items. These results were recorded on-line and analyzed as to the number of correct responses. Of secondary interest was the subject's time spent on the test. Total time was recorded on-line and represented the accumulation of times elapsed between the instant the examinee saw the message on the screen and when he or she entered a response. It did not include pre-test instructional time, screen refresh time, or end-of-test instructions. Subjects' profile scores were recorded off-line as a measure of their computer expertise.

The analysis consisted of calculating overall statistics on user performance such as test scores, profile scores, and test time. Experienced and inexperienced users were also compared on these variables. In addition to this comparison of test scores and test times, qualitative experience with various microcomputers and operating systems was also correlated with test scores.

The 40 users were divided into two groups of 20, with one group (the inexperienced users) having user profile scores below the median (Md = 16.0) and the other (experienced

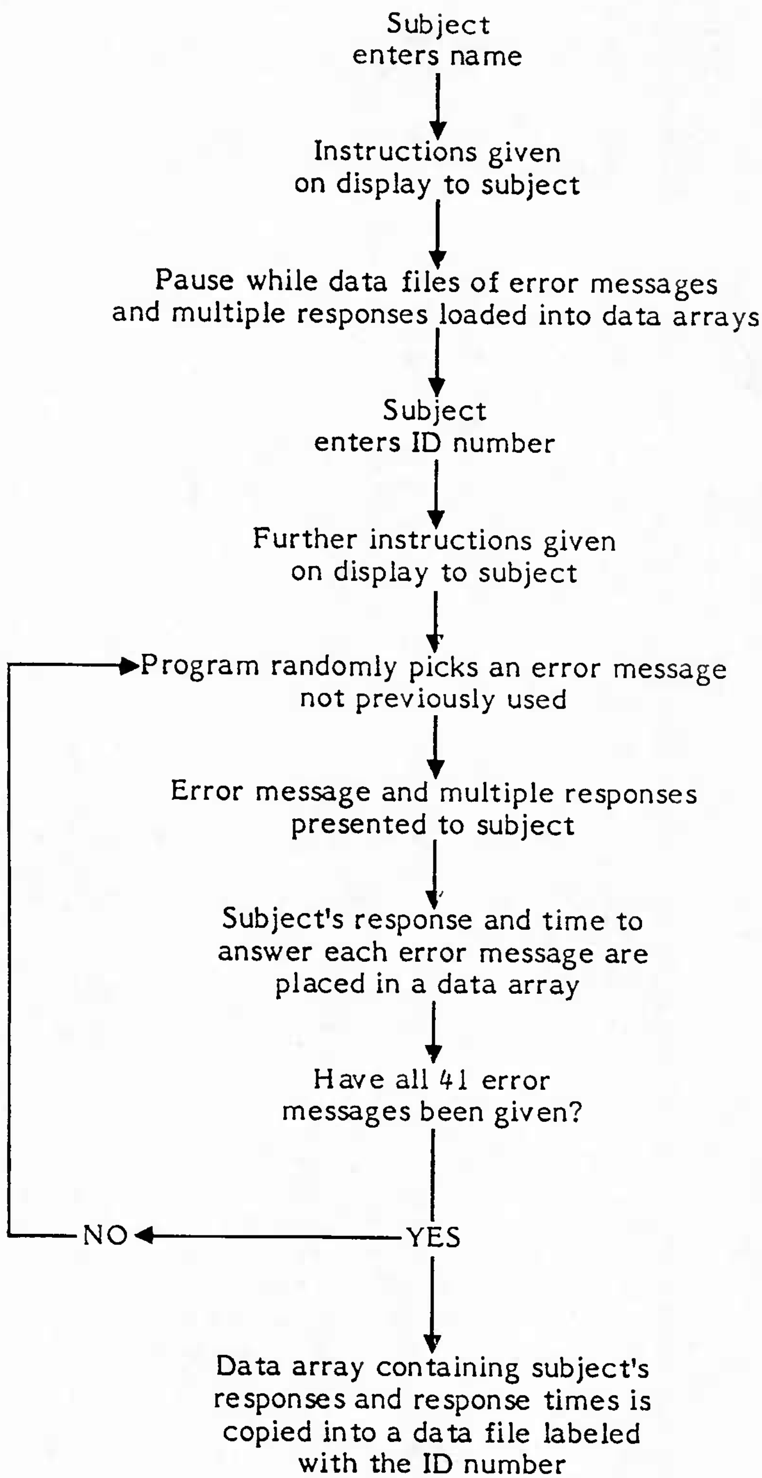


Figure 2. Flowchart of error message test program.

users) having profile scores above the median. A subject with a profile score just below the median (e.g., 14.0-16.0) had typically completed only one computer course, been exposed to one programming language, used a computer for two purposes, used only one interactive computer system, and had experience with only one operating system. The division of users into these two groups produced the expected significant difference ($p < .001$) in experience level as measured by the User Questionnaire. This difference was useful for studying the effect of experience on error message interpretation.

## RESULTS

### Group Performance

The mean test score (number of correct responses) for all users was 23.3, with a high score of 32 and a low score of 14; the standard deviation was 4.2. Test scores varied less than profile scores, having half the range and standard deviation. The average score of most achievement tests should fall about midway between a chance score and a score of 100 percent (Marshall & Hales, 1972). With a 41-item test, chance score on 4-choice items equals 25 percent, or 10.25, so the midscore should equal (41.0 -10.25/2) + 10.25 = 25.6. The mean test score of 23.3 was thus 2.3 points less than the recommended score. Marshall and Hales (1972) also advise that the mean of the indices of item difficulty should fall midway between chance score and 100 percent (25 percent -100 percent) or 62.5 percent. The mean of the item difficulty indices of the error message test was 23.3/41 or 56.8. The best estimate of test reliability is Saupe's formula R16K, reported by McMorris (1972), which yields a reliability coefficient of 0.64. A corresponding standard error of measurement ($SE = SD\sqrt{1 - R}$) resulted in 2.52, relatively small compared to many achievement tests (McMorris, 1972).

### Experienced Versus Inexperienced Users

After the degree of accuracy was determined to be at only 57 percent, an analysis was done on the effect of experience in interpreting error messages. The test scores of the experienced and inexperienced groups were compared and are displayed in Table 1.

Table 1

Comparison of Inexperienced and Experienced Group Test Scores

| | Inexperienced Group ($n$ = 20) | Experienced Group ($n$ = 20) |
|---|---|---|
| Low score | 14.0 | 20.0 |
| High score | 29.0 | 32.0 |
| Mean | 21.5 | 25.2 |
| Standard deviation | 4.2 | 3.5 |
| $t$ ($df$ = 38) | -3.0, $p < .01$ | |

The difference between the means of the two groups is 3.7, with the experienced group performing significantly better ($p < .01$). Previous computer experience does appear to be a central factor determining successful error message interpretation even when users are removed from the actual on-line computer task. The correlation between user profile score and test score was 0.36 for inexperienced subjects and 0.34 for experienced subjects--both nonsignificant at the 0.01 level.

Of interest also was to see how test time compared between the inexperienced and experienced groups, Table 2.

Table 2

Comparison of Inexperienced and Experienced Group Test Times (Minutes)

| | Inexperienced Group ($n$ = 20) | | Experienced Group ($n$ = 20) |
|---|---|---|---|
| Lowest time | 8.3 | | 7.4 |
| Highest time | 29.5 | | 27.1 |
| Mean | 14.1 | | 14.1 |
| Standard deviation | 5.8 | | 5.8 |
| $t$ ($df$ = 38) | | 0.00, N. S. | |

Because of their previous exposure to the types of error messages employed in the test, it was also expected that the Experienced Group would be able to complete the test items faster. However, the analysis shows the means and standard deviations of test times for the two groups to be essentially identical. Thus the superior performance of the Experienced Group can not be attributed to its spending any greater time on the error interpretation task.

Predictors of Success

The correlation between profile score and test score for all 40 subjects was 0.53 ($p < .01$). A regression analysis of profile subscores to predict test performance revealed that the number of operating systems that subjects experienced explained as much variance, 31 percent, in test scores as did the entire profile score. So, successful interpretation of error messages was more a function of the number of operating systems that the user had experienced than any other component or combination of components comprising the profile score. Item score and time correlation was only 0.34--so the more difficult error message did not necessarily take more time to interpret.

Since 73.2 percent of the error messages used were common to the IBM PC system (Figure 1), IBM PC users ($n$ = 13) were compared with non-IBM PC users ($n$ = 27). IBM-experienced users, who were largely a subset of the experienced user group ($n$ = 20), did better than non-IBM users in interpreting error messages. The mean test score for IBM PC users was 25.9, significantly greater than the 22.1 of non-IBM users ($p < .01$). Mean time scores were also similar: 13.2 minutes for IBM users compared to 14.5 minutes for all non-IBM subjects, and 14.1 for both experienced and inexperienced user groups (Table 2).

Attributes of System Error Messages

Listed in Table 3 are those messages for which users demonstrated a high degree of comprehension and those for which they did not. Nine messages are listed in descending order of comprehension for each category.

Table 3

The Most and Least Understood Error Messages

| Most Understood (85-100 Percent Comprehension) | | Least Understood (10-25 Percent Comprehension) | |
|---|---|---|---|
| Question Number | Message | Question Number | Message |
| 2 | Insufficient disk space 0 file(s) copied | 10 | Illegal entry |
| 13 | Try again | 40 | Not found |
| 23 | Sector not found | 22 | Read fault |
| 36 | Incorrect DOS version | 16 | Too many parameters entered |
| 39 | No room in directory for file | 28 | Access denied |
| 14 | Damaged disk | 25 | Write fault |
| 38 | Invalid directory | 31 | Backup file sequence error |
| 30 | Attempted write protect violation | 26 | Write protect |
| 15 | Disk not formatted | 20 | Invalid drive specification |

The relationship between length of message and comprehension is not clear. The 41 error statements varied from one to nine words with a mean of 3.3. The mean correct comprehension rate across all 41 items was 57 percent, with a low score of 10 percent for question 20 (invalid drive specification), and a high score of 100 percent for question 2 (insufficient disk space). The standard deviation of the percentage scores across all items was 27 percent. The least understood messages were successfully interpreted below the chance level (25 percent). However, within these nine items, there were at least two other alternatives chosen by subjects. Usually one highly attractive, but incorrect alternative misleads most users, which is typical of multiple-choice tests. The word count of the most understood messages averaged more than three words and for the least understood message less than three words. It may be that three words represent the minimum required to produce an understandable prompt. However, correlation between word count and message comprehension for all 41 error statements was only 0.26.

The most understood messages are more specific in terms of Shneiderman's (1982) dimension. All but two (questions 13 and 30) refer to a physical entity such as a disk, directory, file, or sector. Interestingly enough, questions 26 and 30 resulted in extreme differences in interpretation, although the only difference between them was the addition of words "attempted" and "violation" in question 30.

Both the most and least understood messages suffer from lack of constructive guidance. The exception is question 13, which directs the user to take further action, but without specifying a cause for it. Physical format was constant in all messages and the style did not vary noticeably across the 41 items. Scapin (1981) found computer-oriented commands to be more easily understood than directions that used ordinary language. Shneiderman (personal communication, 1984) reports from recent studies that a positive tone is ineffective in increasing message comprehension. Some respondents performed better to prompts that were stated negatively. However, Shneiderman advocates using user-centered language that allows the user to control the system rather than the system directing what the user does. Prompts should avoid the imperative forms, such as ENTER DATA, and focus on user control, such as READY.

## DISCUSSION AND CONCLUSIONS

The population of computer users can be expected to grow at a high rate for the next several years. However, the largest growth will be among people who will use computers on a periodic basis (often referred to as discretionary users). These are the people who will be encountering error messages most frequently because of limited experience.

The results of this study indicate that people do learn to interpret error messages better with experience. This fact, however, is of little comfort to the discretionary user who will use the system, but not frequently enough to gain sufficient experience to become proficient. Additionally, the poor level of performance of experienced users indicates that the interpretability of these error messages is still far below what should be expected for a system that is to serve discretionary users as well.

On the average, subjects correctly interpreted 23.3 error messages or only 57 percent. Error messages need to be much more understandable for users to perform efficiently on their systems. When more experienced users are separated out, mean performance increases only to 25.2 or 61 percent correct interpretation of error messages.

The difference between inexperienced and experienced users in their ability to interpret error messages is significant, which further highlights the inadequacy of command system prompts for inexperienced users as well as for people who have worked on numerous microcomputer systems in a variety of contexts. For them, system message interpretation should be near perfect. Time on task was not a factor in explaining the difference between experienced and inexperienced subjects, for both groups' means and standard deviations of performance time were practically identical. The generalizability of these results is strengthened by the subject sample, which represents a wide range of ages and educational levels. It included civilian and military personnel, students, clerical and professional people, and people of both sexes.

The error messages were for tasks related to both device and data-handling functions, tasks well within the realm of achievement by the most inexperienced user. The error messages themselves are commonly used--73 percent of them were derived from software designed for the most popular microcomputer on the market and 44 percent from software designed for a microcomputer used most frequently by the military. Users of the most popular system fared better than did the experienced group as a whole and their performance was significantly better than that of people inexperienced on that system.

## RECOMMENDATIONS

The need to improve system error prompts so that they are unambiguous and comprehensible is of high priority. Shneiderman (1982) suggests principles of system message design: Messages must be specific, offer constructive guidance, employ user-centered phrasing, and be presented in an appropriate format. Most importantly, a prompt should be specific and prescriptive, two dimensions that offer the most promise for improving user-computer communication.

Inexperienced users suffer the most from incomprehensible feedback. All users do poorly when the context of the task and the situational cues of the on-line operational environment are absent. But error messages should not be dependent on contextual cues, which may not exist. The user needs to be told exactly what he or she has done wrong and what needs to be done to recover from the error and correct the situation.

A study based on the results of this experiment would be one that takes the inadequate error messages identified here and redesigns them, demonstrating their relative effectiveness through replication. This could be done by rewriting those messages that yielded less than 30 percent correct interpretation. Those items that already yield a high percentage of correct interpretations could be used as controls for test-retest reliability. Effective messages should continue to be effective, and redesigned messages should reflect considerable improvement as measured by scores for correct interpretation.

## REFERENCES

Baggett, P. (April 1983). Four principles for designing instructions (Office of Naval Research, Code 458). Boulder, CO: Institute of Cognitive Science, University of Colorado.

Ehrenreich, S. L. (1985). Computer abbreviations: Evidence and synthesis. Human Factors, 23(3), 365-375.

General Services Administration. (1985). Automatic data processing equipment in the U. S. Government (FY 1984 Summary). Washington, DC: Federal Equipment Data Center (KHEE), General Services Administration.

Kincaid, J. P., & Delionbach, L. (1973). Validation of the automated readability index: A follow-up. Human Factors, 15, 17-20.

Marshall, J. C., & Hales, L. W. (1972). Essentials of testing (pp. 78-82). Philippines: Addison-Wesley.

McMorris, R. F. (1972). Evidence on the quality of several approximations for commonly used measurement statistics. Journal of Educational Statistics, 9(2), 113-122.

Scapin, D. L. (1981). Computer commands in restricted natural language: Some aspects of memory and experience. Human Factors, 23(3), 365-375.

Shneiderman, B. (1982). System message design: Guidelines and experimental results. In A. Badre and B. Shneiderman (Eds.), Directions in human computer interaction (pp. 55-78). Norwood, NJ: Ablex.

# APPENDIX A

# ERROR MESSAGE TEST INSTRUCTIONS AND QUESTIONS

## TEST INSTRUCTIONS

SCREEN

1 Welcome to the Zenith microcomputer,
What is your name? Joe (blinking)

Please wait for the next message to appear on the screen.

2 Joe
This is a survey to gather data for a study on error messages. You will receive no feedback to tell you if your response to a particular error message is correct. Currently, there is no basis for comparison. If you wish to know the result of this survey, please inform the person in charge of the session that you wish to be contacted when the analysis has been completed. PLEASE WAIT FOR A MESSAGE TO TELL YOU WHEN TO BEGIN.

3 Joe, please type in your assigned ID NUMBER.
? 1 (blinking)

Joe,
A series of error messages associated with the ZENITH will be displayed on the screen. Each error message will have 4 responses. Your task is to pick the one best response for each error message.

When you are ready, press any key to start.

SCREEN

4 Question 1 of 41

Which is the best interpretation for the following error message?

File cannot be copied onto itself
0 file(s) copied

a. File to be copied does not exist
b. Error in copy command
c. Second disk to be copied or not specified
d. Insufficient space on disk to make copy

Enter your answer by using one of the letters (a to d) and then press -RETURN-.

Answer ___ (blinking)

All of the following 41 test items are presented with screen (4) format.

## ERROR MESSAGE TEST QUESTIONS

1. File cannot be copied onto itself
   0 File(s) copied
   - a. File to be copied does not exist
   - b. Error in copy command
   - *c. Second disk to be copied on not specified
   - d Insufficient space on disk to make copy

2. Insufficient disk space
   0 File(s) copied
   - a. Copy command error
   - *b. No space on disk to make copy
   - c. File does not exist
   - d. Second disk not specified

3. File not found
   - *a. File not in directory
   - b. Accessing wrong disk drive
   - c. File name in error
   - d. File does not exist

4. Bad command or file name
   - a. Erroneous command name
   - b. File does not exist
   - c. File not in directory
   - *d. Entry error

5. No files
   - *a. File does not exist
   - b. Wrong disk drive specified
   - c. Insufficient disk space
   - d. File extension mission

6. Ø file(s) copied
   - a. Insufficient disk space
   - b. File cannot be copied onto itself
   - *c. Error in copy command
   - d. File(s) not in directory

7. Redo from start
   - a. Retype directory name
   - *b. Reenter command
   - c. Change disk drives
   - d. Log on system again

8. Syntax Error
   - *a. Error in command format
   - b. Entry misspelled
   - c. Error in entry spacing
   - d. Too many parameters entered

9. Entry aborted
   *a. Entry ignored
   b. Returned to system mode
   c. Entry temporarily stored in buffer
   d. Illegal command

10. Illegal entry
   a. Entry misspelled
   b. Error in entry spacing
   *c. Erroneous entry
   d. Syntax error

12. Checksum error
   a. Checksum file does not exist
   *b. Inaccurate data transmission
   c. Recheck all of preceding checksum data
   d. Damaged disk storage

13. Try again
   a. Return key not entered
   *b. Reenter command
   c. File not on disk
   d. Processor not ready

14. Damaged disk
   a. Unformatted disk
   b. Not a Z-DOS disk
   *c. Cannot read to/write from disk
   d. Wrong disk sector size

15. Disk not formatted
   a. Error in command format
   b. Damaged disk
   *c. Disk not prepared for use
   d. Not a Z-DOS disk

16. Too many parameters entered
   a. Too many spaces entered
   *b. Too many alphanumeric characters entered
   c. Parameters outside of acceptable range
   d. Syntax error

17. Reference made to a nonexistent file
   *a. File not in directory
   b. Accessing wrong disk drive
   c. Erroneous file name
   d. File copied onto itself

18. Disk error reading
   *a. Unable to read first disk record
   b. Damaged disk
   c. Unformatted disk
   d. Not a Z-DOS disk

19. Disk error writing
  a. Disk write protected
  *b. Unable to write first disk record
  c Accessing wrong disk drive
  d. Unformatted disk

20. Invalid drive specification
  a. Specified drive not turned on
  b. Specified drive not connected to computer
  c. Specified drive has no disk
  *d. Specified drive contains unbootable disk

21. Non-DOS disk
  a. Accessing wrong disk drive
  *b. Unformatted disk
  c. Current operating system required on computer
  d. Command error

22. Read fault
  a. Read only memory (ROM) full
  b Unformatted disk
  c Current operating system required on computer
  d. Command error

23. Sector not found
  *a. Data sector on disk cannot be located
  b. Unformatted disk
  c. Disk sector damaged
  d. Sector defined by incompatible operating system

24. Seek
  a. File extension mission
  *b. Unable to locate proper disk track
  c. Disk sector cannot be located
  d. Accessing wrong disk drive

25. Write fault
  a. Disk write protected
  *b. Retry
  c. Damaged disk
  d. Abort

26. Write protect
  a. Disk program copyrighted
  b. Files not on disk
  c. Disk full
  *d. Files cannot be detected

27. About to generate.EXE file
  Change disks (hit ENTER)
  a. Accessing wrong disk drive
  b. Unformatted disk
  c. File does not exist
  *d. Insert program disk

28. Access denied
   a. Security violation
   *b. Disk write protected
   c. Disk drive not turned on
   d. Proprietary information

29. All specified file(s) are contiguous
   a. Wrong directory
   *b. Files written sequentially on disk
   c. Files are in subdirectory
   d. Files are separately inaccessible

30. Attempted write protect violation
   *a. Cannot write on disk
   b. Disk unformatted
   c. File cannot be printed
   d. File extension needed on file name

31. Backup file sequence error
   a. Backup file on wrong disk drive
   b. Damaged disk containing file
   *c. Disk with first part of file not inserted
   d. File stored on disk out of sequence

32. Bad or missing Command Interpreter
   *a. COMMAND.COM missing from DOS disk
   b. Damaged system disk
   c. Unformatted disk
   d. DOS system disk write protected

33. Cannot edit.BAK file--rename file
   a. File not on disk
   b. Disk write protected
   c. Accessing wrong disk drive
   *d. Cannot change backup file

34. Disk boot failure
   a. Disk has incompatible operating system
   b. Accessing wrong disk drive
   *c. DOS failed to load into memory
   d. Hardware malfunction

35. Divide overflow
   *a. A program tried to divide by zero
   b. Insufficient disk space to store answer
   c. Variable for answer not defined large enough
   d. Trying to divide by too large a number

36. Incorrect DOS version
   a. CPM disk used
   *b. Wrong version of DOS used
   c. Wrong disk drive used
   d. Disk damaged

37. Invalid baud rate specified
   a. Printer buffer overflow
  *b. Computer to printer data transmission rate unsynchronized
   c. Incorrect port connection to printer
   d. File too large to be printed

38. Invalid directory
   a. No files in directory
   b. Directory is full
  *c. Directory in specified path does not exist
   d. Directory name previously used

39. No room in directory for file
   a. Directory name contains too many characters
  *b. Directory on specified file is full
   c. Extension needed for file name in specified directory
   d. Directory reserving space for a subdirectory

40. Not found
   a. Disk not labeled
   b. File not on disk
   c. Unable to access specified disk drive
  *d. String specified by EDIT command not found

41. Printer error
   a. Error in print command
   b. Printer queue is full
   c. File not saved before printing
  *d. Printer is off-line

# APPENDIX B

# USER QUESTIONNAIRE

User No. ____

## USER QUESTIONNAIRE

Please complete the following questionnaire. Your answers will be completely confidential. The responses you give will be used only to study differences between people of different backgrounds as to how they relate to knowledge of and proficiency with computers. Check the appropriate items that apply to you.

Gender: Male (1) ____ Female (2) ____

Age:
- 15-25 years (1) ________
- 26-35 years (2) ________
- 36-45 years (3) ________
- 46-55 years (4) ________
- 56-65 years (5) ________
- 66 and over (6) ________

Indicate <u>highest</u> general education level:

- Less than high school graduate/equivalency (1) ________
- High school graduate/equivalent (2) ________
- Associate Arts Degree (2 years college) (3) ________
- Bachelor's Degree (4) ________
- Master's Degree (5) ________
- Doctorate Degree (6) ________

Number of computer-related (information science, data analysis, computer-assisted instruction languages, etc.) courses completed:

- (0) None ________
- (1) One ________
- (2) Two - four ________
- (3) Five or more ________

Specialized computer training:

| | | (0)____None | Number of hours used last month = |
|---|---|---|---|
| Programming languages used = | | | |
| Assembler | (1) | ________ | ________ |
| Fortran/Cobal | (2) | ________ | ________ |
| Basic | (3) | ________ | ________ |
| APL | (4) | ________ | ________ |
| PL1 | (5) | ________ | ________ |
| Pascal | (6) | ________ | ________ |
| Ada | (7) | ________ | ________ |
| "C" | (8) | ________ | ________ |
| Others ________ | (9) | ________ | ________ |
| ________ | | ________ | ________ |

Do you use a computer at home and/or at work?

(0) No ___ (1) Yes ___

What percentage of your working time is spent using a computer?

(0) None ________
(1) 0-10% ________
(2) 11-25% ________
(3) 26-50% ________
(4) 50% ________

For what purposes do you use a computer?

(0) None ________
(1) Word processing ________
(2) Games ________
(3) Programming ________
(4) Telecommunications/message handling ________
(5) Educational/tutorials ________
(6) Data base mgt./business applications ________
(7) Other ________

How many word processing text editors have you used?

(0) None ________
(1) One - three ________
(2) More than three ________

List any interactive computer system (stand-along or time-sharing) you have used:

(0) None ________
(1) ________
(2) ________
(3) ________
(4) ________
(5) ________
(6) ________

What operating systems have you used?

(0) None ________
(1) CPM ________
(2) Z-DOS ________
(3) MS-DOS ________
(4) UNIX ________
(5) Other ________
________
________

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